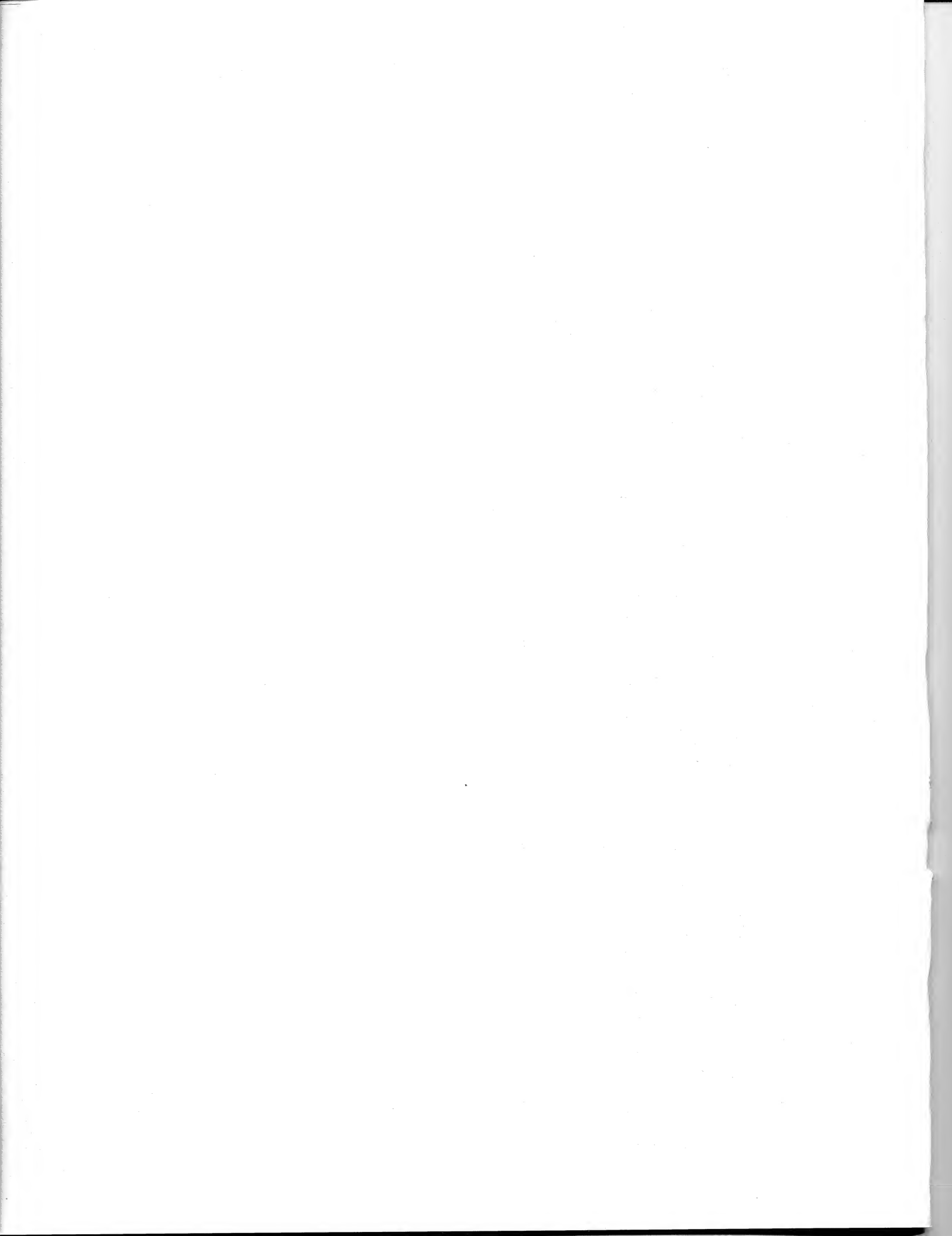


T.M.

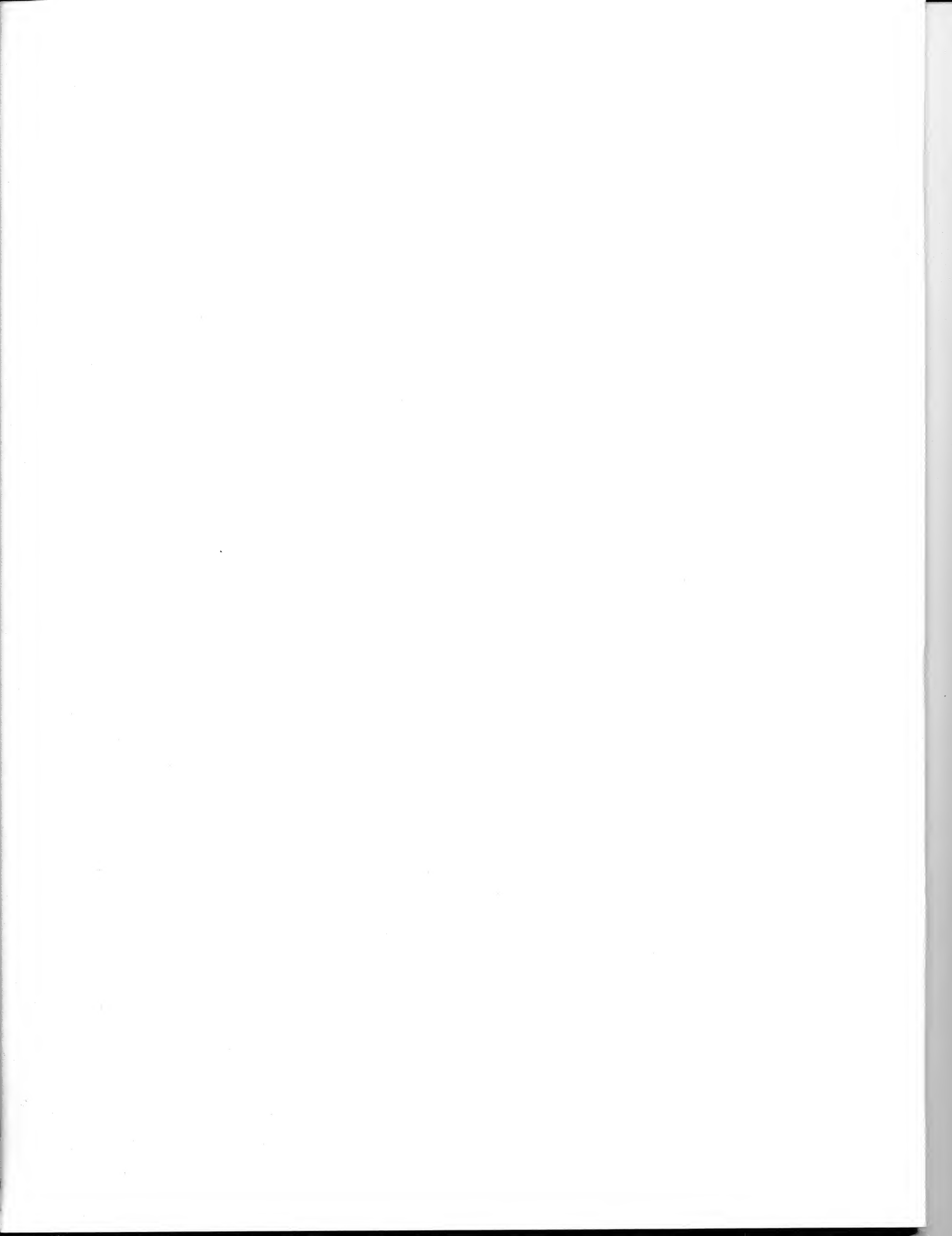
GENERAL INFORMATION
MANUAL

MODEL 6111
DATASTAKTM STORAGE SYSTEM

***P** data products corporation*



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MANUAL
MODEL 6111
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contents

description	5
Introduction	5
The Discs	5
The Disc Pack	6
The Flying Heads	6
The Comb	7
The Positioner	7
The Electronics	8
The Drive Unit	8
Factors Affecting Access Times	9
Transfer Rates	9
Formatting	10
Storage Capacity	11
system operation	13
Signal Sequence	13
Signal Function	14
general characteristics	15
Power Requirements	15
Physical Specifications	15
Environmental Specifications	15
Reliability	15
Maintenance	16



The Model 6111 DATASTAK System with the 611 Disc Pack in operational position

description

introduction

The Model 6111 DATASTAK System provides rapid and random access to a large amount of on-line data with convenient access to any desired amount of off-line data. The DATASTAK System utilizes *removable and fully interchangeable* disc packs. This disc pack concept is affording an economic and opportune solution to numerous current data processing storage problems.

Each removable pack can provide storage for related system programs, object programs, subroutines and often-used index tables. An entire file of variable data for a specific computation can be conveniently available without wasting costly on-line storage space or suffering time-consuming off-line dump delays. The disc pack combines the advantages of *unlimited storage* previously available only with tapes, with the *random-access* characteristics of inherently reliable disc memories.

The disc pack provides an excellent means for preserving classified information since the packs may be stored in a vault when not in use. The DATASTAK system also offers the feature of *write lockout* protection. Critical data may be preserved from erasure or writing by locking out the disc pack. The discs are locked out by removing a small snap-out ring from the top of the pack. This provides fail-safe lockout, since the pack casing is never separated from the discs. In addition, any drive unit may be placed in the write lockout condition. Thus, the programmer may preserve any pack or group of packs from erasure or may allocate any drive unit for reading only.

The Model 6111 DATASTAK Drive Unit system utilizes the Model 611 Disc Pack. Each Drive Unit can accommodate a single, removable disc pack which stores up to 7.36 million, 8-bit bytes. The disc pack contains six discs or twelve storage surfaces. Ten surfaces normally store data, the eleventh is a spare, and the twelfth is used for control information. The number of drive units utilized for on-line storage is dependent upon the particular data processing application. The removable disc packs allow the user to acquire any amount of low-cost, off-line storage.

Each Model 6111 Drive Unit contains a single electromechanical positioner which drives a comb-type mechanism. The comb consists of twelve arms, each of which carries a head pad assembly. Thus, at any location, the comb accesses a *cylinder* of twelve tracks, ten of which may be used to store data.

The positioner must move the heads rapidly across the disc surfaces and position them precisely to the addressed cylinder. The positioner exhibits a random average positioning time of 60 milliseconds. The average cylinder-to-cylinder positioning time, which is particularly significant in sequential processing, is 30 milliseconds. Switching time between heads is less than 50 microseconds. This delay does not affect access time since it is less than that required for mechanical tolerances.

There is an extra track available on each disc surface for accessing with a *fixed head*. One fixed head track is reserved for timing and control information. The eleven remaining fixed head tracks are optional* and may be used for additional fast-access data storage or for special format control.

The Model 6111 features the option of *fixed or variable* length records. This formatting flexibility, combined with a convenient and versatile interface, results in compatibility with all major electronic data processing systems. The basic system interface comprises the minimum number of signal lines required to address a cylinder, select a head and transfer data. The exact interface configuration depends upon the choice of options desired; e.g., fixed or variable length records, fixed heads, etc.

The DATASTAK System is designed to operate in a typical commercial data processing environment. However, there is always the possibility of some contaminants which could affect the overall reliability of a disc memory. The DATASTAK System is engineered to minimize the effects of these contaminants. The design of the disc pack and drive unit mechanism is intended to maintain a permanent *clean room* environment for the discs, even when the pack is being removed or replaced. Although all reasonable precautions should be exercised to maintain a clean installation, the DATASTAK design eliminates severe "housekeeping" requirements.

the discs

The DATASTAK storage medium is a result of many years experience in the manufacture of magnetic discs. The discs are completely processed by automated machinery engineered and fabricated by *data products corporation*

The discs consist of an aluminum substrate coated with a tough, thermosetting plastic, dispersed with magnetic oxide. The coating is only 150 microinches (about 4 microns) thick and is much harder and more abrasion resistant than any coating previously used for

* Prices for options will be supplied upon request.

discs. The entire disc manufacturing process is precisely controlled and the coated discs are tested to ensure that the entire surface is capable of reliable recording.

The nominal recording density is 1660 bits per inch using a phase-modulated recording technique. Each track has a total capacity of 46,936 bits. The discs rotate at a speed of 1800 rpm for both 50 cps and 60 cps operation.

the disc pack

The Model 611 disc pack is a rugged, compact assembly designed, in conjunction with the drive unit mounting mechanism, to maintain a permanently clean environment for the discs. The entire pack weighs less than ten pounds and is very convenient to store. The disc pack, which is illustrated in Figure 1, consists of a protective casing and the disc assembly.

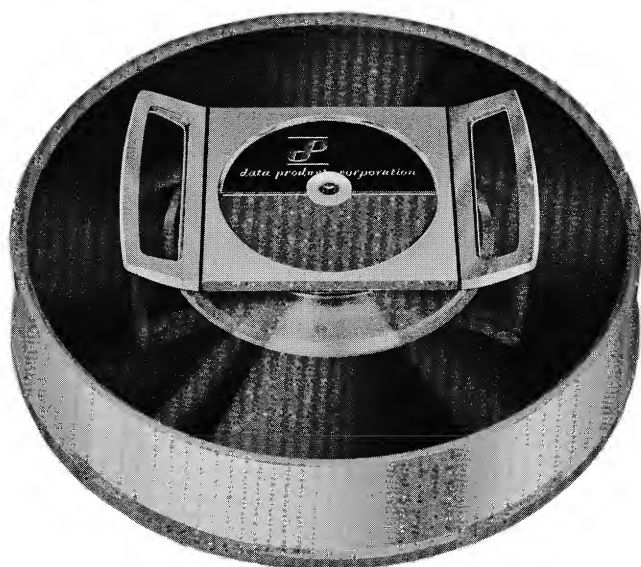


FIGURE 1 THE 611 DISC PACK

The disc assembly contains six discs which are mounted on a cast aluminum cylindrical hub and separated by aluminum spacers. The bottom baffle plate is attached to the hub and rotates with the discs. A ground stainless steel tube, which is used to locate the pack accurately on the drive mechanism, is located in the center of the hub. The tube is protected by a hard plastic cover which is removed before the pack is placed in the drive unit.

The disc assembly is housed in and protected by a cylindrical casing. The top surface of the casing is clear plastic, and two aluminum handles are provided for ease of placement. After the disc pack is inserted in the drive unit, this casing is raised above the discs by an elevator mechanism to allow the heads access to the discs. Before removal, the casing is lowered over the discs and the disc pack is removed as a unit. In this manner, the casing is always associated with the same disc assembly.

A slot is provided in the center of the handle assembly for insertion of a write-lockout ring. Unless this ring is in place, the discs cannot be erased or written upon. A label on the handle assembly provides a means for easily identifying the disc pack and its contents. When removed from the drive unit, the disc baffle plate is pressure sealed by a gasket on the bottom of the cylindrical casing, preventing the disc assembly from rotating within the pack. A polyurethane foam case is provided for thermal and shock protection during shipment.

the flying heads

The flying head assembly is a simple and highly reliable mechanism which maintains the erase and read/write gaps at a very small but precisely controlled distance from the disc surface. The head pad is a slider air bearing which is held away from the disc surface by a thin but resilient boundary layer of air which rotates with the disc. The layer maintains the read/write gap at approximately 50 microinches from the surface. A simple mechanical means is used to force the head pad against the boundary layer to create the slider bearing effect.

The flying head assembly*, illustrated in Figure 11, consists of a gimbal assembly, a core assembly, and a head pad. The gimbal assembly transmits the loading to the head pad and ensures that the pad pivots only in those directions required to follow any fluctuations in the disc surface. The pad, when loaded, creates the slider bearing effect and serves as a vehicle for the core assembly. The erase and read/write coils are part of the core assembly.

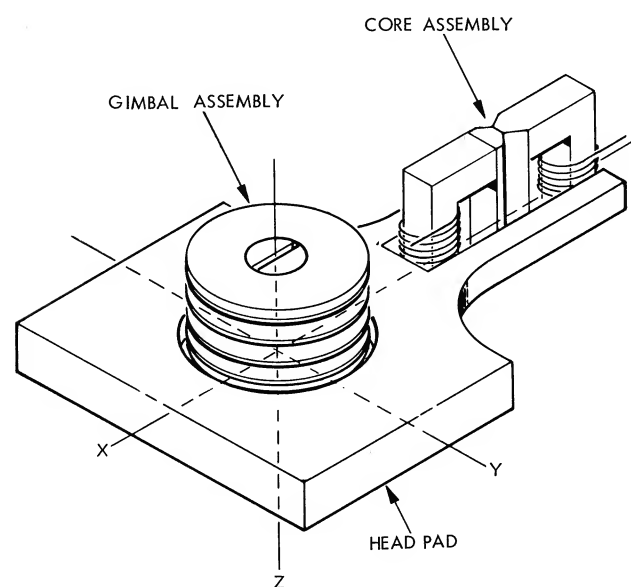


FIGURE 11 FLYING HEAD ASSEMBLY

The construction of the gimbal assembly is illustrated

* Patent pending

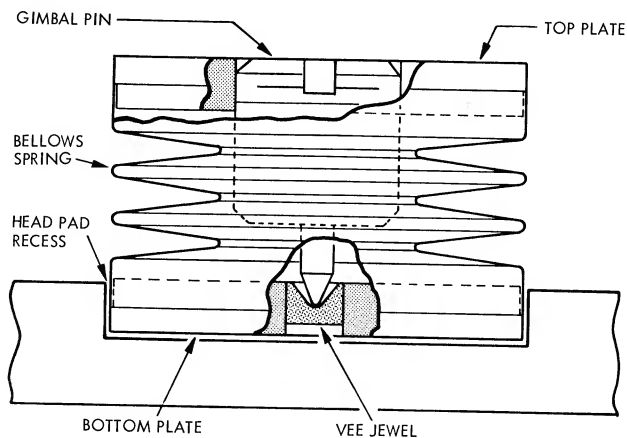


FIGURE III GIMBAL ASSEMBLY

in Figure III. The bellows spring provides torsional rigidity about the axis perpendicular to the disc surface (axis Z in Figure II). The head pad is free to pivot around axis Y, to follow undulations along the circumferential length of a track or around axis X to follow undulations experienced in traversing radially across the disc. The load to the head pad is transmitted through the gimbal pin at the pivot point. The head pad is restrained around the vertical axis since any rotation would cause the erase and read/write gaps to stray from the center of a track.

the comb

The comb assembly is illustrated in Figure IV. The comb assembly carries twelve aluminum, cantilevered arms. Two arms are mounted in each of six slots in the arm housing. A reference sideplate is mounted on one side of the arm housing and a diode head switching board is mounted on the other side.

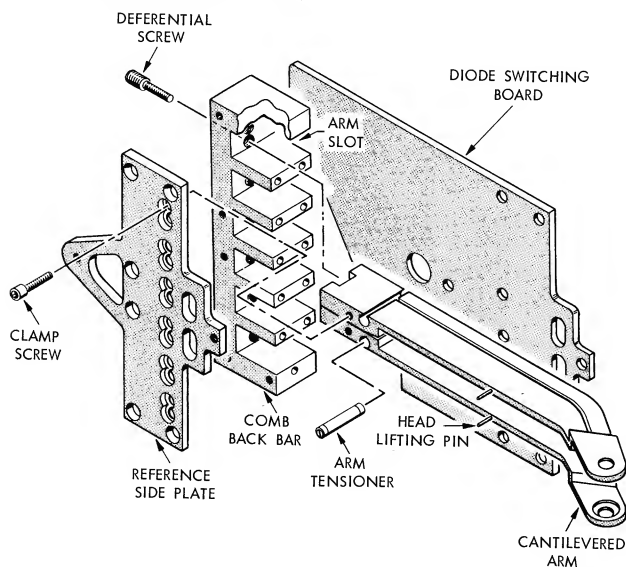


FIGURE IV COMB ASSEMBLY

When the arm is inserted in a slot, a differential

screw is used to align it radially to the disc surface. A clampscrew is then tightened to pull the arm against the reference side plate, ensuring that all twelve arms assume the same angular position. The force applied to the head pad is controlled by adjusting a tensioner inserted in the arm. The differential screw and tensioner adjustments are only required when an arm is replaced.

A pin projecting from the side of each arm rides over a cam when the comb is being inserted or retracted. When the arms are inserted, the cam restrains the head from landing until it is located over the recording area. When retracted, the head is raised from the disc surface before reaching the edge of the disc. The cam maintains support of the head until the arms are again inserted between the discs. The arms are not inserted until the discs are up to speed and are automatically retracted in the event any mechanical or power failure occurs.

the positioner

The positioner is an electromechanical, closed loop servo device which drives the comb mechanism rapidly and positions it precisely to the addressed location. The servo motor supplies a simple driving source providing high reliability and minimum maintenance.

All pertinent mechanical components of the positioner are of aluminum, as are the discs, and have the same temperature coefficient. This minimizes the effect of any temperature variations normally experienced in a data processing environment.

When a new address is transmitted to the servo the typical response curve is as illustrated in Figure V. The

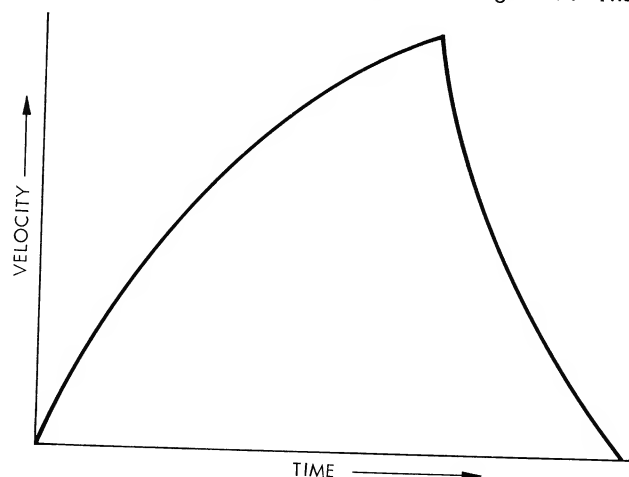


FIGURE V POSITIONER RESPONSE CURVE

servo is controlled such that the acceleration and the higher derivatives are minimized while obtaining the fastest possible motion and the minimum positioning time.

Two transducers control the servo. One provides approximate positioning information which restrains the overall motion within defined acceleration limits. The

other provides precise positioning and generates a "positioner settled" signal which indicates that reading or writing may proceed.

Figure VI illustrates the positioner assembly. A printed circuit motor drives the comb and head assembly by means of a rack and pinion. The carriage which carries the comb is guided by a set of instrument bearings.

A limit stop assembly automatically retracts the arms from the disc surfaces when power is removed or when any power or mechanical malfunction occurs. The carriage is cushioned at both extremes of travel.

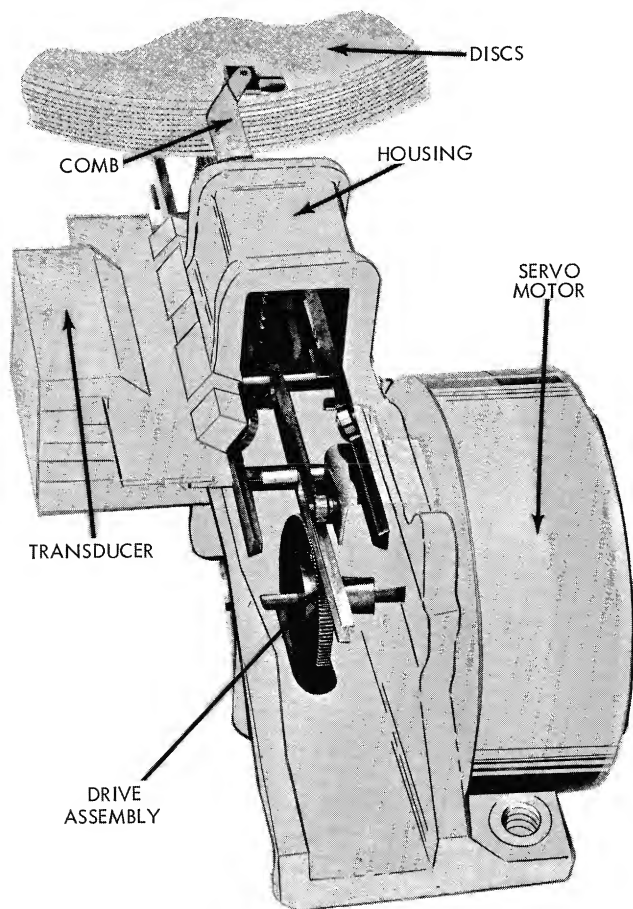


FIGURE VI POSITIONER ASSEMBLY

the electronics

Each drive unit contains the required electronics to write and read data and to respond to data processor commands. The electronic circuits are mounted on compact printed circuit boards and all solid state elements are silicon. The majority of the circuits utilize integrated components. The proprietary read/write circuits are not yet available in the integrated form.

Each board incorporates a "ground plane" which

mates with redundant ground plane shielding in the mounting module. This arrangement results in virtually complete freedom from radiation interference problems. All critical circuit test points are conveniently accessible by means of lugs located at the front of the board. Each circuit board measures 3-7/8 inches by 2-3/8 inches and mounts to the module by means of a 45 pin connector.

The low level amplifier stages are predominantly differential pair amplifiers with heavy feedback which provides very high common mode noise rejection. The logic circuits provide high-speed current steering. The typical board contains four flip-flops or seven NOR gates.

The standard interface uses current levels and current pulses. Optional circuits are available for voltage modes. The current is supplied from a positive voltage and is referenced at a nominal +6 volts for the transmitter and a +1 volt for the receiver. Simplified circuit diagrams of the transmitter and receiver are shown in Figure VII.

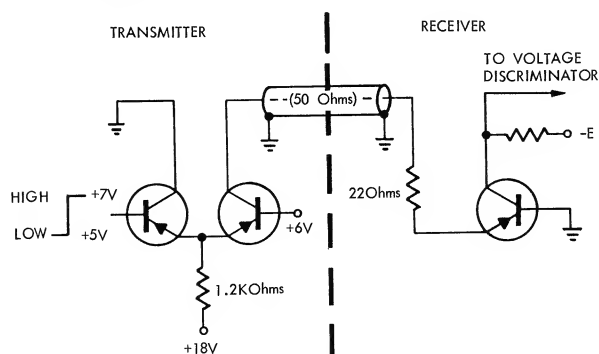


FIGURE VII CURRENT MODE INTERFACE LOGIC

There are two standard current states. The LOW state is the quiescent state for pulses and is represented by less than two milliamperes. The HIGH or active pulse state is represented by 9 ± 2 milliamperes. Transitions between the states should occur between 10 and 100 nanoseconds. A pulse should remain at the high state for more than 20 nanoseconds and should remain above the 50% level for between 80 and 160 nanoseconds.

the drive unit

The Model 6111 Drive Unit is a compact and convenient handler, designed to ensure complete interchangeability for the packs. Each drive unit contains a precision spindle, an elevator mechanism, a source of ultra-clean air, a servo positioner and comb mechanism, and the electronics and power supplies required to transfer data and operate the positioner.

The area containing the spindle, elevator, positioner

and comb mechanisms is sealed and pressurized with the clean air. The spindle is exposed by lifting the protective lid when removing or replacing a pack.

The nose of the spindle contains a specially tooled collet which grips the stainless steel shaft of the disc pack. When mounting a pack, a floor pedal is operated and the disc pack is placed, intact, on the collet. Releasing the floor pedal locks the collet to the shaft and causes a flange on the elevator to grip the pack cover. The collet precisely orients the disc pack to the comb mechanism, ensuring complete repeatability when reading data from various packs.

A key, which is tied to a retractable pulley in the disc mounting enclosure, is used to unlatch the pack casing from the disc hub. The casing is then raised until the elevator latches are in the up position, permitting the comb mechanism to access the discs.

The disc mounting enclosure is continuously pressurized with 3 micron filtered air. When the pack is placed on the collet, the air is passed through a secondary filter in the hub and forced outward over the surfaces of the discs. Note that the interior of the casing is never exposed unless it too is pressurized. This "clean room" concept contributes significantly to the high reliability characteristics of the DATASTAK system.

A panel in the mounting enclosure provides lamps which indicate the status of the mechanism (i.e., pack down, elevator latched, etc.). In addition, there are switches which may be used to dial a number identifying the drive unit. This number is supplied to the interface and is also indicated by digital lamps on the drive unit control panel. Thus, the data processor receives a direct identity code of the drive unit or units in line, and this number can easily be observed by the central processor operator.

Factors affecting access times

There are several factors affecting the access times to data in a random-access, mass storage device. The significance of each factor and, in turn, the overall speed of the device, depends to a large extent on the particular application. The application must be analyzed to obtain an accurate estimate of the time required to perform any single operation or series of operations.

The components of access time in the DATASTAK system are positioning time and latency.

Positioning time

Positioning time begins with the presentation of a new address to a drive unit. Positioning time ends with the

indication that the positioner is settled. Reading or writing may commence as soon as the data processor is notified that the positioner is settled. Figure VIII shows average positioning times for various stroke lengths.

Once the positioner is settled, the heads remain over the addressed cylinder until the positioner is re-addressed. Thus, the access time to any data within the cylinder is a function only of rotational latency.

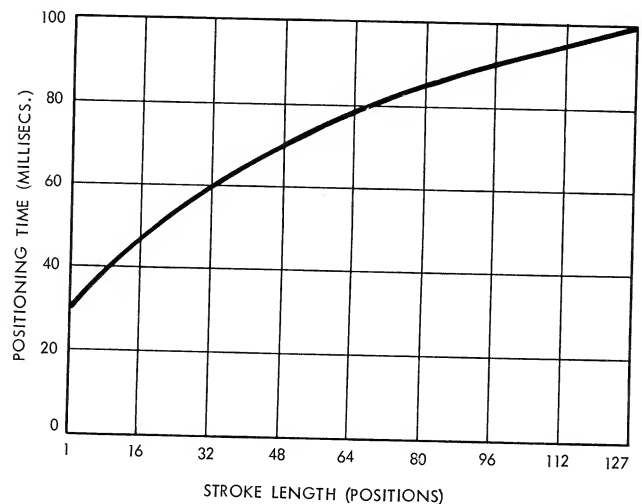


FIGURE VIII AVERAGE POSITIONING TIME

It should be noted that the positioning curve is a function of the number of positions moved and does not directly indicate the speed of the device. The random average access time to data that is distributed throughout the storage area of the pack is a function of the average number of strokes of various lengths and the time required to complete the strokes. In the dp/f 6111 system, this time is less than 60 milliseconds.

The effects of positioning time can be further reduced by utilizing the multiple seek capability which is inherent in any DATASTAK system utilizing more than one drive unit. The feature is implemented by overlapping seek operations; i.e., the data processor may actuate a positioner in one drive unit and then proceed to a second drive unit while the first is seeking a track. Thus, the data processor may reduce overall access times by time-sharing positioning times.

Latency

Latency is dependent upon the rotational time of the discs and the lengths of the records on the track. The disc rotational time is fixed at 1800 rpm with 50 or 60 cycle operation. The length of the records depends on the particular format chosen. However, latency will average one-half a disc revolution time, or 17 milliseconds.

Transfer rates

The transfer rate for a disc memory is a function of the

rotational speed of the discs and the density at which the information is written. The discs rotate at 1800 rpm and data is written at 1660 bits per inch. This results in a nominal transfer rate of 1400 kilobits per second and a corresponding nominal bit-to-bit timing of 700 nano-seconds.

formatting

The DATASTAK System is designed to provide the user with a wide range of formatting flexibility. The system is designed to permit the data processor to control the length and number of records on a track. This variable length record capability provides the data processor with optimum efficiency in utilizing the storage area.

The system supplies permanently recorded clock pulses which define the basic frequency at which data is written. These timing pulses are read from a track on the control disc by means of a fixed head. This timing track also contains an index pulse which defines the beginning of each track.

Thus, the data processor uses the index pulse as the basic reference for the beginning of each track. The system is mechanized such that the data processor may specify the beginning of each variable length record by means of a special address mark. This mark is written at the convenience of the data processor and is unique in that it is written at half the normal clock frequency.

Variable length records must be prefixed by a header which is used to provide pertinent infor-

mation about the record. Typically, the header contains information which defines the location (cylinder, head, record number) of the record and information which specifies the content and length of the variable portions of the record.

The data processor may desire to incorporate a key area preceding the actual data. The key area identifies the data portion of the record by content; e.g., employee number, inventory number, etc. A file of data may then be content searched, optimizing such routines as sorting, updating, etc.

variable record length format

Figure IX illustrates a typical format arrangement when utilizing variable length records. The arrangement shown includes all the control information required to provide a complete description of the data recorded on the track. The utilization of all or part of these information groups and the precise length of each group is dependent upon the particular application.

The track contains three general types of information referred to as the home address (HA), the track descriptor (TD) record and the variable length records (R_1 through R_N). Each address mark, home address and track descriptor record must be preceded by a gap. This gap is required to accommodate the physical displacement between the erase gap and the read/write gap in addition to the required data synchronization. The gap preceding the home address is longer to accommodate mechanical tolerances between the heads on the comb.

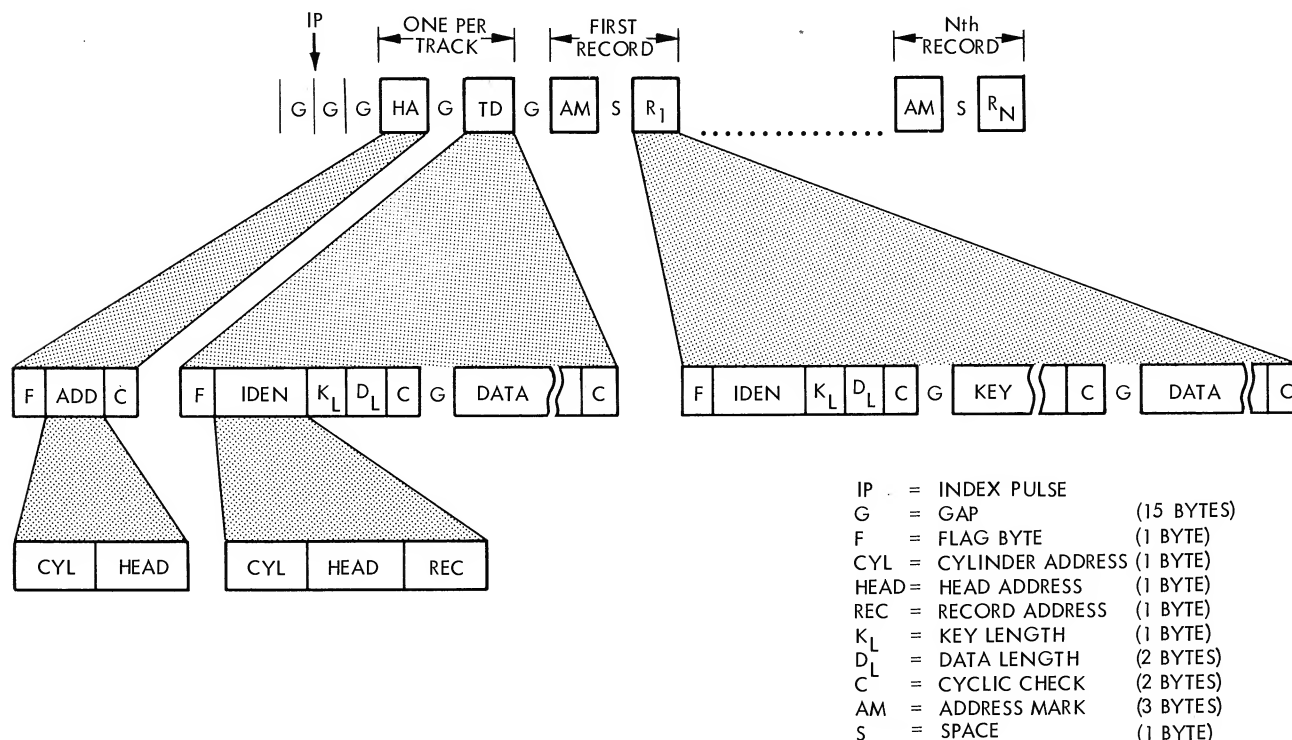


FIGURE IX TYPICAL VARIABLE LENGTH RECORD FORMAT

A single home address and a single track descriptor record are written at the beginning of each track. The number of variable length records written is determined by the data processor. The following format description utilizes the 8-bit byte as the basic data unit.

the home address

The home address defines the location of the track and is written a specified distance after the index pulse (IP). The home address would typically contain a flag byte, a cylinder and head address and two check bytes.

The flag byte is used to indicate the integrity of the track recording area. The home address identifies the cylinder and the head associated with the track. The check bytes are an arithmetic function of the preceding information in the home address, used for checking when reading.

the track descriptor record

The track descriptor record may be used to specify an alternate track in the event that the associated track is defective. When a track is defective, the track descriptor record will instruct the data processor to switch to the spare track in the same cylinder. Accessing the desired record is then only a function of latency. Very rarely, more than one bad track will occur within a cylinder. In this case positioning time is required to access the alternate track. The track descriptor record is not preceded by any marker, since it always follows the home address.

The track descriptor record is arranged in the identical format as the variable length records. The record consists of a header and a data area. (The variable length record may also contain a key area but this is normally zero in the track descriptor record.) The identical format results in logic simplicity when buffering and processing the records. The length of the data portion of the record is dependent upon the amount of information required to specify the alternate track, if required. In the format illustrated in Figure IX, the data area of the track descriptor record would specify the alternate cylinder and head requiring two bytes.

the variable length record

The variable length record contains a header area, key area (if required) and a data area. The header begins with a flag byte which is identical to the flag byte in the home address. The identifier portion specifies the cylinder, head and record number. The key length indicates the number of bytes used in the key portion of the record. The data length specifies the number of bytes in the data portion of the record. Each area is appended by two check bytes.

The variable length key and data areas are written with each area preceded by the appropriate gap. The cyclic check bytes are appended to each area for checking

when reading. The header, key and data areas may be written sequentially or independently. The precise sequence of recording these areas is under control of the data processor.

fixed length record option

The capability of writing fixed length records is inherent in the mechanization of the variable length record formatting. However, the user may prefer that the record length be controlled by the DATASTAK System, thereby eliminating some formatting logic in the controller.

The fixed record length option is mechanized by supplying sector marks to the interface from an additional track on the control disc. The sector marks are equally spaced about the circumference of the track; the number of sector marks recorded is at the option of the customer.

When utilizing the sector marks, the data processor writes a header at the beginning of each sector. This header identifies the cylinder, head and record number. The headers are then used to locate the desired sector when writing and reading data.

Each header and data record must be preceded by a gap to accommodate mechanical tolerances and by a synchronizing pattern to facilitate reading.

storage capacity

In the DATASTAK System, the control disc clock track fixes the maximum number of bytes which can be written on a track at 5867. This figure does not directly indicate addressable storage capacity because of the format control information and the synchronizing and tolerance gaps which are associated with each record. To determine addressable storage capacity, it is necessary to consider the maximum bytes available per track, the length of the records to be stored, and the record format.

variable length record capacity

The variable length record track format illustrated in Figure IX specifies the type and length of control information on the track, and the number and length of gaps associated with that information.

The home address and the gaps required before and after the index pulse consume a total of 50 bytes. The track descriptor record and the gap preceding that record require a minimum of 24 bytes. The maximum available storage per track is therefore equal to 5793 bytes ($5867 - 74$).

Each record written on the track also requires space for synchronizing gaps, the header used to identify the

record, and cyclic check bytes. This space totals 62 bytes if a key area is contained in the record, and 45 bytes if the key area is not used. The total number of bytes in a variable length record may be expressed as follows:

$$45 + C + (KA + DA)$$

Where: KA = bytes in key area
DA = bytes in data area
C = 17 if KA ≠ 0
C = 0 if KA = 0

When only a single record is written per track (following the track descriptor record) and KA = 0, the equation for maximum bytes in the data area is:

$$5793 = 45 + C + (KA + DA)$$

$$5748 = DA$$

When multiple records are written on a track, and the key areas and data areas in each record are of equal length, track storage capacity in terms of records is as follows:

$$N (\text{records}) = \frac{5793}{45 + C + (KA + DA)}$$

Therefore, if KA = 10, DA = 215,

$$N = \frac{5793}{45 + 17 + 10 + 215}$$

$$N = 20$$

For a number of equal-length records (N) per track, maximum bytes (B_R) available for key and data areas in each record may be expressed as:

$$B_R = \frac{5793 - N(45 + C)}{N}$$

Table I lists the number of records available using different sectoring arrangements and the corresponding

RECORDS PER	RECORDS PER TRACK			
	1	8	16	32
Cylinder	10	80	160	320
Disc Pack	1280	10,240	20,480	40,960
BITS PER				
Record	46,000	5449	2552	1104
Track	46,000	43,592	40,832	35,328
Cylinder (x10 ³)	460	436	408	353
Disc Pack (x10 ⁶)	58.9	55.8	52.3	45.2

TABLE I CAPACITY IN RECORDS AND BITS

capacities in terms of data bits. Table II lists capacities in terms of 8-bit bytes utilizing the above formulas; i.e., the figures reflect actual data capacity excluding all control information, gaps and any required cyclic check information.

BYTES PER	RECORDS PER TRACK			
	1	8	16	32
Record	5748	679	317	136
Track	5748	5432	5072	4352
Cylinder (x10 ³)	57.5	54.3	50.7	43.5
Disc Pack (x10 ⁶)	7.36	6.95	6.49	5.57

TABLE II CAPACITY IN 8-BIT BYTES

Table III lists capacities in terms of four-bit decimal digits. This table is computed on the same basis as Table II with two packed-decimal digits per byte. Table IV lists capacities in terms of six-bit alphanumeric characters. The values include one parity bit for every four characters, or 24 bits.

DECIMAL DIGITS PER	RECORDS PER TRACK			
	1	8	16	32
Record	11,496	1358	634	272
Track	11,496	10,864	10,144	8704
Cylinder (x10 ³)	115.0	108.6	101.4	87.0
Disc Pack (x10 ⁶)	14.7	13.9	13.0	11.5

TABLE III CAPACITY IN 4-BIT DECIMAL DIGITS

ALPHANUMERIC CHARACTERS PER	RECORDS PER TRACK			
	1	8	16	32
Record	7360	871	408	176
Track	7360	6968	6528	5632
Cylinder (x10 ³)	73.6	69.7	65.3	56.3
Disc Pack (x10 ⁶)	9.42	8.91	8.36	7.21

TABLE IV CAPACITY IN 6-BIT ALPHANUMERIC CHARACTERS (ONE PARITY BIT PER 24 DATA BITS)

fixed length record capacity

As with the variable record length format, storage capacity when using the optional fixed sectoring is dependent upon the address bytes and check bytes recorded on each track, and the required tolerance gaps.

Associated with each record are four gaps. A tolerance gap of 15 bytes is required before each sector mark and two gaps of 15 bytes each are required between the sector mark and the beginning of the address header. Another 15-byte gap is required between the header

and beginning of data. These gaps allow for mechanical tolerances between the arms on a comb, and for the spacing between read/write and erase gaps. The address header and the two cyclic check bytes associated with the data record total 8 bytes. Thus, there are a total of

68 control bytes required for each sector. Data storage capacity for each track is determined as follows:

$$B_T \text{ (bytes/track)} = 5867 - 68N$$

Where N = number of records per track.

system operation

This section describes the interface characteristics and the command sequence for the DATASTAK System. The basic interface signals are the minimum number required to access a cylinder, select a head and transfer data. Additional lines are provided for system status indications and for any options exercised by the customer.

The system interface, which is illustrated in Figure X, is compatible with the Model 5045-360 DISCFILE® System interface. This provides the customer with the unique capability of incorporating or interchanging removable

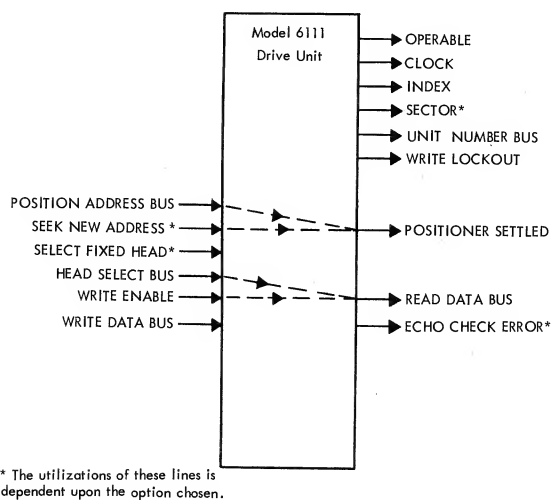


FIGURE X SYSTEM INTERFACE SIGNALS

pack systems with very large capacity, on-line systems without modifying programs.

signal sequence

The system is energized from a control panel on the drive unit. When all interlocks are set and the discs are up to speed, the OPERABLE signal is supplied to the data processor. This signal is maintained as long as the entire system is energized and operating conditions are normal. The OPERABLE signal is removed when the discs are stopped in order to remove and replace a disc pack.

The UNIT NUMBER BUS provides an octal indication

of the unit identifier number selected by the operator. The bus consists of thirteen lines providing indications of octal 0 through octal 47. The selected octal number is also indicated by a digital display located on the drive unit control panel. When the disc pack and/or the drive unit is locked-out, the system supplies a continuous WRITE LOCKOUT indication to the data processor. This line is an open contact when the pack or drive unit is locked out.

In order to access a record, the data processor initially supplies the POSITION ADDRESS. This bus comprises seven lines with logic levels indicating the binary value of the addressed cylinder. The servo positioner is directly slaved to the input address lines, i.e., the positioner immediately responds to any change in the value of the logic levels.

A buffer register option is available which allows the data processor to disconnect after addressing the system. The buffer register option permits the DATASTAK system to control the positioner while it is moving to the addressed position. In this manner, the data processor may use a single address channel to sequentially address several positioners in a multiple drive unit system. When a buffer register is employed, the data processor must follow the presentation of a new POSITION ADDRESS with a SEEK NEW ADDRESS signal. This instructs the system to accept and operate upon the new address.

When the heads are placed over the addressed cylinder, the system supplies the POSITIONER SETTLED level. The data processor then selects a specific track by providing the proper logic levels on the HEAD SELECT BUS. The HEAD SELECT BUS contains four lines which carry the binary coded head address which selects one of the eleven heads. All heads are disabled when the bus levels indicate a decimal zero.

The data processor must record certain information in order to identify the particular storage area. When using variable length records, this information is the home address. When using fixed length sectoring controlled from the system, the data processor must record a header at the beginning of each sector. The control information is then used during subsequent processing to

locate the desired record for writing and reading.

When initially writing data on a track, the data processor utilizes the INDEX pulse to locate the beginning of the track. The CLOCK line is then monitored to define the precise area where control information and data may be written. The system is instructed to write by an active level on the WRITE ENABLE line. This level must be supplied for the duration of each gap to ensure that an erased area is located under the head when writing begins.

The data processor uses the CLOCK pulses to gate data bits over the WRITE DATA BUS. This BUS contains two lines, one for data ONE's and one for data ZERO's. If desired, the optional echo check function is available. The output from the write amplifier is sampled and each data bit is compared with the bit supplied to the write amplifier. A bad comparison results in a pulse on the ECHO CHECK ERROR line.

The READ DATA BUS also contains separate lines for ONE's and ZERO's. When a read operation is desired, the data processor simply maintains an inactive level on the WRITE ENABLE line. The information from the selected track is then supplied over the READ DATA BUS.

When the fixed head option is exercised, the SELECT FIXED HEAD line is used. An enable on this line instructs the system to use the HEAD SELECT BUS to access one of the eleven fixed head tracks.

signal function

The functions of the interface signals are summarized below:

input signals

POSITION ADDRESS BUS (seven lines, levels)

Indicates the binary value of the desired position.

*SEEK NEW ADDRESS (one line, pulse)

When using optional buffer register, instructs system to store position address.

*SELECT FIXED HEAD (one line, level)

Instructs system to utilize head select lines to select a fixed head.

HEAD SELECT BUS (four lines, levels)

Selects one of eleven heads in cylinder.

* The utilization of these lines depends upon the options chosen.

WRITE ENABLE (one line, level)

When active, instructs system to write data.
When inactive, instructs system to read data.

WRITE DATA BUS (two lines, pulses)

Used to transfer write data ONE's and ZERO's.

output signals

OPERABLE (one line, level)

Indicates that the system is prepared to accept an address.

CLOCK (one line, pulse)

Used to transmit basic timing pulses to data processor.

INDEX (one line, pulse)

Used to transmit track reference pulse to data processor.

*SECTOR (one line, pulse)

Used to transmit basic sector reference pulse to data processor.

UNIT NUMBER BUS (thirteen lines, contact closures)

Supplies selected unit identification number to data processor.

WRITE LOCKOUT (two lines, contact closure)

Contact opening indicates that disc pack or drive unit is locked out from erasure or writing.

POSITIONER SETTLED (one line, level)

When active, indicates that positioner is settled over addressed location.

READ DATA BUS (two lines, pulses)

Used to transmit read data ONE's and ZERO's.

*ECHO CHECK ERROR (one line, pulse)

Indicates a bad comparison between bit supplied to write amplifier and the bit supplied to the head.

general characteristics

power requirements

Each drive unit in a DATASTAK System requires 700 watts, single phase, 60 ± 1 cps power at 110 volts a.c. $\pm 10\%$. Optionally, the system can be supplied to operate from other input voltages or from 50 cps line frequency.

physical specifications

the drive unit

Important physical parameters of the drive unit are listed below:

Height	38 inches (96.5 cm)
Width	42 inches (67 cm)
Depth	24 inches (61 cm)
Work Surface Height	34 inches (86 cm)
Weight	600 lbs.
Spindle Speed	1800 rpm (for 50 and 60 cps)

For normal use, access is required to only one side of the unit. Read/write electronics and control logic are mounted in modules behind a door on the front of the unit. Logic modules hinge outward for access to the rear of the circuit boards. Power and signal interface cables may be routed into the unit from under the floor or from the floor surface. Blowers for cooling air are integral with the unit.

the disc pack

Relevant physical characteristics of the disc pack and discs are as follows:

Weight	10 lbs.
Diameter of Case	14-3/4 inches (37.5 cm)
Height of Case	3-1/4 inches (8.25 cm)
Disc Diameter	14 inches (35.5 cm)
Disc Spacing	0.4 inch (1.0 cm)
Effective Storage Area	625 sq. inches (4000 sq. cms)

environmental specifications

The system is intended for installation and operation in an environment associated with electronic data processing equipment. Provision is included for sealing the units during shipment or storage to prevent contamination by dust, moisture, or other contaminants. The operating environment should be filtered to remove 95% of particles above 25 microns. This is typical of data processing air conditioning practice. Other environ-

mental requirements are as follows:

Operating	Storage or Shipment*
Temperature**	
Minimum 50°F (10°C)	-20°F (-30°C)
Maximum 100°F (40°C)	160°F (70°C)
Relative Humidity	
Minimum 20%	
Maximum 80%	98%
Tilt (degree from vertical)	
Maximum 10°	40°
Vibration (above 10 cps)	
Maximum 0.1 g	1 g
Shock	
Drive Unit 0.1 g max.	10 g maximum
Disc Pack 0.1 g max.	50 g maximum
Altitude	
6500 ft. (2000 meters)	15,000 ft. (4500 meters)

reliability

Quality control is of major importance in the manufacture of disc memories. Long-term reliability and extremely low error rates are assured by rigid inspection and control of all materials, components and processes at every stage of manufacture. All the critical parts of the system are manufactured and tested in ultra-clean rooms. Each part is inspected and tested by sensitive and precise optical and electrical devices.

Each major assembly is thoroughly tested when integrated with the system. The system then undergoes a lengthy reliability test before shipment. Field computation conditions are simulated by randomizing data patterns and addresses. No unrecoverable errors are allowed and normally less than ten recoverable errors occur. The equipment should exhibit error rates far lower than those specified in the reliability check, provided that proper scheduled maintenance is performed.

The present state of disc recording technology permits very reliable reading and writing at relatively high frequencies. However, as densities increase, the reliability of the recording medium may be affected due to contamination by very minute dust particles. These

* When a disc pack is stored outside of the operating environmental limits, it must remain in the drive unit environment for two hours before being inserted into the drive unit.

** Storage conditions assume that the equipment is packed in the original shipping case or container.

particles may cause bad spots and resultant loss of data. While techniques are available to prevent these bad spots, economic and reliability considerations dictate the use of spare storage areas to cope with damaged tracks. This is a very desirable solution as long as the customer suffers no loss in overall system capability.

Contrary to the method employed in most disc storage systems, each disc pack contains an entire spare disc surface for storage of data in the event that any bad spots are encountered. This ensures that the specified capacity is preserved for the life of the disc pack, and the user normally experiences no additional positioning time in substituting for a bad storage area.

maintenance

The system should operate for at least five years before major overhaul is required. It is designed to be easily maintained by operating personnel. Access to the unit is convenient and little obstruction is encountered in reaching any internal part. Modules are hinged when necessary. Mechanical adjustments are required only when a part is replaced. The few electronic adjustments need to be checked only about twice a year.

Recommended scheduled maintenance for each Drive Unit is two hours per month. Unscheduled maintenance is unlikely to exceed an average of ten hours per year.

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